Liberalizing Trade, and its Impact on Poverty and Inequality in Nicaragua

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Abstract

The Doha Round of multilateral trade negotiations stalled in 2008 owing in no small degree to a lack of agreement on the terms of substantially reducing trade-distorting support for agricultural products and to what extent this would be beneficial to developing countries. Nicaragua presents an interesting case in point, being one of the poorest economies in Latin America with still a relatively large agricultural sector and high degrees of rural poverty. In 2005, the country signed a free trade agreement with the United States. A previous study showed that most welfare gains of this agreement for Nicaragua would potentially come from the increased market access for textiles and clothing exported to the United States. Under the agreement, the country stands to benefit much less from reducing tariffs on agricultural imports or agro-industrial export quotas. Since the United States is Nicaragua's main trading partner, this raises the question whether further trade liberalization with all trading partners, including full elimination of all taxes and tariffs on agricultural production and trade, would be any more beneficial. Using a CGE model and a microsimulation methodology, this study shows that small welfare gains in terms of increased output and poverty reduction may be expected for Nicaragua under various scenarios of trade opening. At best, however, there would be a static gain in aggregate output of 1.5 percent as compared with the baseline scenario. This outcome would materialize only in a scenario of worldwide liberalization of trade in agricultural and non-agricultural products as this would yield relatively strong positive terms-of-trade effects for Nicaragua. Employment and real wage growth would contribute to poverty reduction, but only very modestly in a country with still widespread poverty. Most of these small gains would accrue to the rural poor. The analysis further shows that these gains tend to be smaller when using trade elasticity estimates based on country-specific data as compared with the much higher elasticities typically assumed by global trade models, including the Global Linkage model.

JEL Classification: C68; F13; F15; F16; I3; O19; O24; O54

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The Doha Round of multilateral trade negotiations stalled in 2008 owing in no small degree to a lack of agreement on the terms of substantially reducing trade-distorting support for agricultural products. The Round aims to address the needs of developing countries, but controversy remains regarding the extent to which reducing trade barriers and domestic support measures for agricultural commodities would in fact be beneficial to developing countries, and in particular whether it would unequivocally reduce poverty. Nicaragua presents an interesting case in point, being one of the poorest economies in Latin America with still a relatively large agricultural sector and a high degree of rural poverty.

At the end of 2005, Nicaragua joined the regional free trade agreement between the Central American countries plus the Dominican Republic and the United States (DR-CAFTA). Before signing the agreement, there was substantial debate especially over concerns regarding its repercussions for poverty, as some feared poverty would become more widespread in rural areas in particular. An ex-ante impact assessment of DR-CAFTA showed that trade opening under the agreement would yield positive overall welfare gains and poverty reduction effects, but that these, at best, would be very small and traditional agriculture and the rural poor would be among the likely losers (Sánchez and Vos 2006a, 2006b). Most welfare gains for Nicaragua from joining DR-CAFTA would come from fully covering an export quota that would provide increased access to textile and clothing markets in the United States, while tariff cuts and expanded agro-industrial export quotas would contribute relatively little. But this agreement liberalizes trade only with the United States. While that is Nicaragua's major trading partner, it raises the question as to whether multilateral trade liberalization involving all trading partners would yield better outcomes in terms of national welfare, poverty and income inequality.

This chapter provides a quantitative analysis addressing that question. It does so using a computable general equilibrium (CGE) model for Nicaragua coupled with a micro-simulation methodology. The first section provides background information on trade reform policies and macroeconomic trends in Nicaragua, with special reference to the agricultural sector and rural poverty. The section that follows describes the main features of the CGE model and the micro-simulation methodology used to assess the impact on poverty and inequality. We then lay out the model scenarios considered, which include liberalizations of agricultural and all merchandise goods trade by the rest of the world and by Nicaragua itself. That is followed by a summary analysis of results. This analysis includes tests for the sensitivity of the results with respect to assumptions regarding the responsiveness of trade to price liberalization, as identified through the relevant trade elasticities. The final section provides conclusions and possible policy implications.

Trade reform, agricultural development and poverty in Nicaragua

By way of background, this section describes the role of trade and agriculture in Nicaragua's economy, the recent liberalization associated with DR-CAFTA, and the remaining national distortions to agricultural incentives before adding a little on the nexus between agriculture and poverty in this country.

Trade and agriculture

Agriculture is a mainstay of Nicaragua's economy, and its share of gross domestic product (GDP) is larger than in other Central and South American countries. The sector's growth averaged a little above 4 percent per year between 1994 and 2006, keeping pace with the rest of the economy and so maintaining its contribution to real GDP at around 20 percent. The nominal

share declined from 32 to 18 percent over that period, however, as factor cost in agriculture increased at a lower rate than the average for the economy as a whole (tables 1 and 2).

Agricultural activity is concentrated in the production of basic staple grains, which dominate land use, and export crops. About 80 percent of cultivated land is rain-fed and planted with corn, beans, rice, and sorghum. Export crops such as coffee, sesame, sugar, tobacco, and peanuts occupy the other 20 percent of arable land. Yet basic staple grains contributed no more than 30 percent of agricultural GDP in 2006, while export crops contributed 50 percent and other crops and livestock the remaining 20 percent.

Nicaragua's agricultural sector achieved a high but volatile rate of growth during the 1990s. Most of this growth was achieved by bringing more land into cultivation (World Bank 2003), rather than through productivity gains which were mostly in large-scale export agriculture. Between 1990 and 2000, the share of land under cultivation increased from 51 to 57 percent of the total land area, but that share has not expanded since then.

Agricultural exports account for between 50 and 70 percent of Nicaragua's total merchandise export earnings. Coffee exports alone make up between 25 and 30 percent of the total value of exports, depending on the price of coffee. Coffee has been a major engine of growth for Nicaragua, contributing on average 5.3 percent of GDP and generating 32 percent of rural employment during the 1990s. About 30,000 households grow coffee and another 150,000-200,000 households receive some part of their income as full-time or part-time labourers in coffee production, processing or marketing. Together, coffee and fish contributed about 40 percent of total exports in the 2000s.

Agricultural exports increased by just 20 percent in the period between 1990 to 2006, much less than elsewhere in Latin America. Traditional agricultural exports grew relatively strongly during the first half of the 1990s, but since then most export growth has been dominated by non-traditional products which now comprise almost two-thirds of total merchandise exports (table 1). All types of exports recovered notably in the early 1990s following the lifting of the trade embargo with the United States and when the period of macroeconomic instability ended. Non-traditional export growth was stimulated by special export promotion measures, including the creation of an Export Processing Zone (EPZ). The EPZ has favoured the development of '*maquila*'-type production of textiles and apparels, an industry that is highly import dependent and yet has created many new jobs. Nearly 40 percent of non-traditional export growth during

2000-2005 is accounted for by the *maquila* industry. Owing to its high import content, the *maquila* industry has only weak linkages with the rest of the economy.[1]

Trade reform and DR-CAFTA

Nicaragua joined the Central American Common Market in 1960 with the aim of pursuing deeper regional economic integration. Trade with the rest of the world was liberalized in the early 1990s, following a decade of civil strife and an international boycott. Around 1990 the pacification process got underway and financial and commercial relations with the United States and with multilateral financial institutions were restored. Unilateral trade liberalization was part of a broader set of market-oriented reforms. Tariffs on imports were reduced, including for agricultural commodities and processed food products. Also, all state monopolies trading food staples, quantitative restrictions on imports and exports, and import surcharges were phased out, and customs procedures were simplified. Most export taxes were eliminated in 1993 and the agricultural sector has benefited from tax exemptions for imports of raw materials and capital goods. Temporary tax-credit certificates, heavily used in the 1990s to promote non-traditional exports, were subsequently eliminated. These reforms increased the degree of trade openness, defined as the total of exports and imports in GDP, from 66 to 77 percent of GDP between 1990-94 and 2000-05 (table 1). Greater trade openness has not boosted agricultural productivity, however. Empirical evidence suggests that productivity growth gains have been modest at best and are concentrated in large-scale farm production of export crops while productivity growth has been stagnant in smallholder farming (Deininger *et al.* 2003, Bravo-Ortega and Lederman 2004, World Bank 2003).

The importance of the United States as Nicaragua's main trading partner is likely to increase further with DR-CAFTA. In the period 2000-05, Nicaragua's exports to and imports from the United States represented 42 percent of total exports and 29 percent of imports on average. Under DR-CAFTA, 92.5 percent of Nicaragua's trade with the United States will be fully liberalized over a period of 20 years; and for many of the remaining products, the country's access to the United States market will be enhanced through tariff rate quotas (TRQs) and other

[1] According to data from the Central Bank of Nicaragua, the import/export ratio of the *maquila* EPZ averaged 68 percent per annum in 2000-05, and has been above 70 percent since 2004.

preferential access quotas. In return, Nicaragua will offer the United States greater access to its domestic markets. The weighted average tariff rate for imports from the United States in 2003, just before the signing of DR-CAFTA, was around 6.2 percent, and it is projected to fall to 0.2 percent by 2020. Agricultural sectors would initially retain greater protection against agricultural imports from the United States. The reduction of tariffs on agricultural goods will be gradual, especially for so-called "sensitive products" such as rice, beans, corn, meats, dairy products, and sugar cane. For some of these products, DR-CAFTA includes safeguard measures in the event of massive imports, and some of these products have been excluded from the tariff reduction program (such as white corn). Even so, tariff cuts for agricultural imports from the United States would be ample: by 2020, the weighted average tariff rate should have dropped to 2.1 percent (Figure 1). Domestic agricultural producers in Nicaragua fear this trade opening will put many of them out of business and induce more rural poverty, especially if farmers in the United States continue to be subsidized.

The United States has also agreed to open up its market for Nicaraguan exporters under DR-CAFTA. Reductions of tariffs on imports from Nicaragua are likely to have a minor impact, since these tariffs are already fairly low and even non-existent in some cases due to unilateral preferences granted by the United States through the Generalised System of Preferences (GSP) program and the Caribbean Basin Initiative (CBI) and its extensions.[2] Nearly 80 percent of Central America's exports to the United States already are subject to duty-free access for most products owing to United States' unilateral preferential programs (USTR, 2005). Therefore, it may be expected that exports from Nicaragua to the United States will not increase notably through further tariff cuts. However, DR-CAFTA makes previously unilateral preferential access permanent under its ruling. Unilateral preferences from the United States can be revoked at any time for countries that do not have a trade agreement with the United States. Exports from Nicaragua to the United States are expected to increase more notably if TRQs granted by the United States are fully utilised. Nicaragua also obtained temporary preferential access quotas, or Tariff Preference Levels (TPLs), which allow use of third-country yarn and cloth if equal amounts of United States cloth are imported. In the case of Nicaragua, up to 100 million square

[2] The CBI trade preferences were granted to the countries of the region by the Caribbean Basin Economic Recovery Act (CBERA), enacted in 1983 and put into effect beginning January 1, 1984. The benefits of the CBI were expanded in 2000 with the enactment of the Caribbean Basin Trade Partnership Act (CBTPA) which allows duty-free and quota-free treatment for certain apparel assembled in qualified CBI countries, and applies reduced tariffs to certain other previously-excluded products.

meter equivalents (SMEs) of clothing would be allowed to enter the United States annually free from rules of origin restrictions for the first ten years; a benefit owing to its status as a heavily indebted poor country (HIPC).

Distortions to farmer incentives

Domestically produced farm inputs are not subsidised in Nicaragua, but the agricultural sector (including light processing of food) historically receives some output price support. Agricultural activities by and large go untaxed.[3] Furthermore, imported inputs for agricultural production and some agro-industries are exempt of duties. Export taxes were non-trivial in the past, but these have been by and large eliminated. Export subsidies are very limited and are being phased out to comply with WTO commitments. Taken together, the overall nominal rate of assistance (NRA) to farmers in Nicaragua on average has been close to zero since the early 1990s, with import-competing assistance (which rose to 2000 but has since fallen to near zero) slightly more than offset by export taxation on a production-weighted basis (Figure 2). The slightly negative NRA for tradable agricultural products contrasts with the average NRA for non-farm tradables which has been around 10 percent, so the relative rate of assistance[4] has fluctuated between -5 and -15 percent since the early 1990s (figure 3). As of 2004, the direct influence of trade and agricultural policies on farm prices in Nicaragua is thus rather modest. This is important for the simulation analysis presented below: it leads one to expect that the estimated impact on farm output and the economy generally of eliminating agricultural taxes and subsidies would be small.

Agriculture and poverty

Agricultural growth can be effective in reducing poverty because the vast majority of Nicaraguan farmers are small-scale producers and many of them currently are poor. The agricultural sector's

[3] Agricultural producers only pay arbitrary municipal taxes on sales and services, real state, and registrations and licenses. They also pay a tax under the administration of *Instituto Nacional Tecnológico* (INATEC) to collect a mandatory 2 percent contribution from payrolls in the formal sector.

[4] The relative rate of assistance is defined as $100*[(100 + NRAag^t) / (100 + NRAnonag^t)) - 1]$, where $NRAag^t$ and $NRAnonag^t$ are the percentage NRAs for the tradables part of the agricultural and nonagricultural sectors, respectively.

rapid broad-based growth in the 1990s possibly represented the single most important cause of the significant reduction in poverty that occurred between 1993 and 2001 (table 3 and World Bank 2003). However, the sources of this growth – high export commodity prices, the availability of unoccupied land, and a return to normalcy after a decade of civil war – were temporary. None of these factors can be expected to be pillars of sustained growth in the years ahead. Indeed, world prices for Nicaragua's main export crops experienced declines and substantial volatility during 1998-2001 such that, in some rural areas, poverty increased, especially in the principal coffee growing areas of the Central Rural region where farmers are most vulnerable to price shocks. National poverty continued to decline though, mainly on account of the post-Mitch reconstruction boom, which came to an end in 2001. After 2001, buoyant commodity prices in world markets, including coffee and basic grain prices, helped boost agricultural incomes leading again to a period of declining rural poverty. That is, improved living conditions were not underpinned by any substantial farm productivity improvements but rather by more fortunate world market conditions.

Modelling the macro-micro impact of trade liberalization

Given the above developments, we now seek to examine the impact on national economic welfare, inequality and poverty of price-distorting agricultural and trade policies at home and abroad that were still in place in 2004, the latest year for which there is a complete dataset of such policy measures for the world (compiled by Anderson and Valenzuela 2008 and made available for modelers by Valenzuela and Anderson 2008). To provide a quantitative *ex-ante* assessment of removing those policies, we use a computable general equilibrium (CGE) model of Nicaragua tailored for income distribution and poverty analysis. The model builds on the authors' earlier analyses (e.g., Sánchez and Vos 2006a, 2006b) which link a country-specific CGE model and a micro-simulation methodology. A distinctive feature of the present analysis is that it also makes use of the World Bank's Linkage model to provide the external terms of trade shock from rest-of-world trade liberalization. We also use for the first time the new farm price

distortions estimates for developing countries compiled by Anderson and Valenzuela (2008), including those for Nicaragua, in order to assess the impact of rest-of-world trade reform on the country's income inequality and poverty. The World Bank's Linkage model is well documented by its creator (van der Mensbrugghe 2005), so the present section outlines just the CGE model for Nicaragua.

Theoretical foundations of the national CGE model

To analyze the impact of agricultural and total trade liberalization on Nicaragua, we use a CGE framework that consists of a static and a dynamic block. The static part of the model provides within-period equilibrium solutions, starting from the base year, and it shares most of its features with the generic CGE model developed at the International Food Policy Research Institute (IFPRI) and documented in Löfgren et al. (2002).[5] The main changes made to the generic model are the inclusion of bilateral trade in import and export functions and an export-demand function, a decomposition of foreign savings into capital flows and foreign direct investment, and a wage function to deal with sector-specific conditions regarding wage indexation and labor market adjustment.[6]

The dynamic part of the model is recursive in the sense that it connects the within-period equilibrium solutions over time through updates of stock variables (particularly factors of production) and selected parameters that are either fixed or absent in the first within-period solution and through lagged variables. All within-period equilibrium solutions are consistently linked for the desired number of simulation periods (years), generating the so-called baseline scenario.[7]

Trade is modelled using a standard Armington constant-elasticity-of-substitution (CES) function defining optimal combinations of domestically-produced and imported commodities. The model also includes an export supply function of the standard constant-elasticity-of-

[5] This model belongs to the family of structuralist-neoclassical general equilibrium models developed for trade policy analysis, for which the theoretical foundations can be found in Dervis *et al*. (1982) and Robinson (1989).
[6] The first two extensions were made because the model initially was used to assess the impact of DR-CAFTA on Nicaragua's economy (Sánchez and Vos 2006a, 2006b).
[7] A more-detailed description of the dynamic recursive CGE framework for Nicaragua can be found in Sánchez and Vos (2006a, 2006b) while a summary of the model equations can be found in the Appendix.

transformation (CET) format although, as explained below, exports are effectively driven in the model by world demand. Both export and import functions are adapted to account for bilateral agreements with trading partners (see equations 21-2 and 25-6 in Appendix). Tariff reductions can be simulated by adjusting the tariff parameter in the equation that determines domestic prices of imports by commodity and trading partner (see equation 1 in Appendix). Likewise, changes in export taxes or subsidies are transmitted through the equation that defines the domestic price of exports by commodity and trading partner (see equation 2 in Appendix). World import prices in the definition of domestic prices can be manipulated to impose terms-of-trade shocks (see equation 1 in Appendix).

As mentioned above, the model also specifies an export demand function by commodity and by trading partner (see equation 24 in Appendix). The function serves to link Nicaragua's CGE model to a global trade model and facilitates performing simulations of worldwide liberalization of trade and agricultural domestic prices. The Global Linkage model of the World Bank is used to simulate the liberalization of trade and agricultural domestic policies in the world excluding Nicaragua. These simulation results provide information on expected changes in world import and export prices and in the demand for Nicaraguan exports which are subsequently imposed on the Nicaraguan CGE model.[8] Unlike typical country models, global trade models mostly do not use CET functions to define export supply behaviour of individual countries. Instead, they assume downward sloping export-demand schedules derived from the Armington assumption applied in import behaviour of trading partners. To match information from both types of models, the CET function was not removed from the Nicaraguan CGE model, but instead the elasticities of transformation were given the very high value of 20 such that the CET function no longer has any major influence on export supply behaviour and exports become in effect driven by demand shifts.[9] By implication, the small-country assumption no longer holds.

Factor market closure rules

[8] For these purposes we followed the procedure spelled out in Horridge and Zhai (2005) and designed to connect the GTAP model and a country model.

[9] Sánchez and Vos (2006a, 2006b) include the export-demand function for different practical purposes for their modeling of the impact of DR-CAFTA in Nicaragua. They used it to impose changes in export quotas by exogenously changing the base-year quantity of exports (that is, the shift parameter in the export demand function).

In the base-year solution, capital is assumed to be underutilized and fixed and cannot be reallocated across sectors. Activity-specific rents assure that fixed activity utilization levels are consistent with profit maximization, through a flexible adjustment of activity-specific wage-distortion factors.[10] Firms are allowed to increase their capacity utilization rate in response to increased demand for capital in the subsequent period solutions, however, such that capital is not longer fixed. The capital market begins to clear through a flexible adjustment in the economy-wide rent with the activity-specific wage-distortion factor remaining fixed. Aggregate real investment generated at the end of each period is reallocated in order to use it as capital in the next period. This is done by allowing activities with higher past profitability to gain larger shares of investable funds, as suggested in Dervis, de Melo and Robinson (1982). The ratio of aggregate real investment at the end of the past period to the aggregate capital stock at the beginning of the past period determines capital stock growth for sectors and the economy. The initial economy-wide and sectoral capital stocks in any given period (excluding the base year), are defined as the capital stock of the past period adjusted by the growth rate of the capital stock less the rate of depreciation.

Labor is classified by occupational category (wage and non-wage), skill level (skilled and unskilled) and gender (male and female). The quantity of labor demanded of each type is assumed to be endogenous in all period solutions and for all activities, except in the cases of fishing and mining. Labor supply is assumed to increase at constant population growth rates for each category. Wage adjustment rules are specified as much as possible in accordance with the existing institutional setting of labor markets in Nicaragua. The market clears in all segments (with a few exceptions) through adjustments in the level of employment, implying there is unemployment in the economy and activity-specific wages are fixed. Wages are not fully fixed for unskilled workers and for skilled workers in government services and public utility sectors, but are indexed to consumer prices following trade-union bargaining. Another exception is workers in fishing and mining sectors, who in the case of Nicaragua, tend to have difficulty in finding jobs in other sectors. Hence, labor is assumed to be specific to these two sectors, that is, the demand for workers in these sectors is fixed and the activity-specific wage equilibrates the labor market (through changes in the activity-specific wage-distortion factor).

[10] The activity-specific wage of each factor is the product of the economy-wide wage of the factor (that is, the average wage by factor type) and an activity-specific wage-distortion factor. The latter measures the extent to which base-year activity-specific wages deviate from the economy-wide wage by factor type.

Macroeconomic closure rules

Macro-closure rules are the same for both the base year and all other period solutions. In the fiscal adjustment process, government savings are assumed to be fixed (at the base-year level) and direct tax rates adjust so as to maintain real government spending and fiscal balance. For the purposes of the present analysis the distributional effects across domestic institutions of the changes in direct tax rates have been kept neutral. This government closure rule enables us to calculate the amount of direct taxes that would need to be collected in order to compensate for any loss of revenue from taxes on trade (net of any subsidy change) in each trade liberalization scenario. The exchange rate adjusts so as to maintain a fixed current account balance in nominal terms (that is, foreign savings are fixed). Investment is savings-driven: private savings from domestic non-government institutions are determined endogenously using fixed marginal propensities to save. Aggregate investment passively adjusts to match aggregate savings.

Model calibration and baseline

The base-year calibration of the Nicaraguan CGE model is implemented using a Social Accounting Matrix (SAM) for 2000. This matrix was compiled by the authors in collaboration with government experts from Nicaragua.[11] The key economic activities and commodities relevant for the analysis of trade liberalization, including special entries for the commodities produced in the EPZ, are all captured in the SAM. Nicaragua's SAM (and CGE model) has 40 productive sectors and the same number of commodities. In addition, the SAM has external accounts for trade and other current-account flows, disaggregated by main trading partner.

Since 2000 is the base year of the SAM, the model is solved recursively up to 2004 to enable us to conduct counterfactual simulations of what would happen if the protection structure was fully dismantled in 2004. Prior to conducting the counterfactual simulations, the SAM was complemented with other data so as to generate two alternative baseline scenarios for the period from 2000 to 2004. In the first baseline scenario, the dynamic recursive CGE model was solved using two types of Armington elasticities, borrowed from the World Bank's Global Linkage

[11] A detailed description of the construction of Nicaragua's SAM is found in Sánchez and Vos (2006b, Appendix A3).

model. At the top level of the nested function are the elasticities of substitution between domestic goods and aggregate imports. These were used in the Nicaraguan CGE model to calibrate the Armington function exponent (see equations 25-6 in Appendix). At the second level are the so-called elasticities of substitution across imports which in general are defined as the top level elasticities times two. In the Nicaraguan CGE model, these were used to calibrate the export-demand function exponent (see equation 24 in Appendix). In the second baseline scenario, the Armington elasticities are parameter values estimated by the authors using country-specific data and sensitivity analysis.[12] The country-specific Armington elasticities range from 0.46 to 1.42 for the top-level elasticities and 0.83 to 2.83 for the second-level elasticities, while those from the Global Linkage model are between 2.08 and 5.91, and between 4.16 and 11.82, respectively. Hence, trade liberalization policies will likely produce weaker trade effects for Nicaragua when country-specific elasticities are used. Consequently, different assumptions regarding the Armington elasticities may also yield different welfare effects.[13]

The two baseline scenarios differ solely in their Armington elasticities. All other model parameters and elasticities were estimated based on country-specific data, as explained in more detailed in Sánchez and Vos (2006b) where the data sources and the estimation methods are listed and described. In addition, base-year employment and population data are from the Employment and Wages Survey produced by Nicaragua's Institute of Statistics and Censuses (INEC) for November 2000. Both population and labour force grow according to estimations provided by INEC to the authors, for 2001-04.

The two baseline scenarios also account for an exogenous update of several parameters. Trade taxes and subsidies were updated for the period 2001-04 using data from the Customs Office of the Ministry of Finance of Nicaragua. The agricultural protection structure was further adjusted to make it compatible with that generated for 2004 by Berthelon, Kruger and Saavedra (2008), which is also what is used for Nicaragua in the Global Linkage model. For this purpose, the Global Linkage model was calibrated using version 7 of the GTAP protection database for 2004 once this had been amended to incorporate new estimates of distortions to agricultural and

[12] The Armington elasticities from the Global Linkage model are not country-specific but rather tend to be equal across countries.

[13] Indeed it has been found that, with weak trade responsiveness, gains from trade could even be reversed. See, among others, Vos (2007) for a review.

food markets in developing countries.[14] To complete the recursive calibration of Nicaragua's CGE model, world export and import prices were also updated to 2004 using trade price deflators provided by the Central Bank of Nicaragua. Autonomous foreign direct investment (and implicitly foreign savings) was also updated for the period 2001-2004 also using data from the Central Bank of Nicaragua. Lastly, total factor productivity was exogenously updated to enable reproduction of actual economic growth during the period 2001-04.

Modelling the impact on poverty

Since CGE models typically only specify a limited number of representative households, they provide insufficient detail regarding changes in income distribution and expenditures to be able to make robust statements regarding poverty outcomes. In consequence, the CGE analysis needs to be supplemented by certain assumptions (such as fixed within-group distributions) or, as has been done for the empirical analysis reported here, by a micro-simulation method that takes the labor market outcomes (relative remunerations, employment, changes in skill levels) from the CGE model for different types of workers and applies them to a micro data set (based on a household survey) to obtain the required details about income distribution for the poverty analysis. Bourguignon, Robilliard and Robinson (2002), Ganuza, Barros and Vos (2002) and Vos et al. (2006) offer a discussion and application of such methods in conjunction with CGE model analysis. The approach followed here is that of Ganuza, Barros and Vos (2002) and Vos et al. (2006), which was designed for application in the context of a static CGE model. This method adjusts the original labor market structure (λ) as observed in a household survey to simulate the sequential effects of a new labor market structure (λ^*) with consequent changes in employment, household income levels and their distribution. The original labor market structure:

$$\lambda = f\left(P_j, U_j, S_{jk}, O_{jk}, W1_{jk}, W2, M_{jk}\right) \quad (1)$$

is adjusted using simulated CGE labor market outcomes to obtain the new labor market structure:

$$\lambda^* = f\left(P_j^*, U_j^*, S_{jk}^*, O_{jk}^*, W1_{jk}^*, W2^*, M_{jk}^*\right) \quad (2)$$

[14] Unlike previous versions of the GTAP database, version 7 merges an input-output table for Nicaragua with world trade flows and protection data. See Badri Narayanan and Walmsley (2008).

where *P* and *U* respectively are the participation and unemployment rates for labour type *j*; *S* and *O* represent the structure of employment by, respectively, sector and occupational category, for labor type *j* in segment *k*; *W1* is the relative remuneration (i.e. relative to the mean) for labor type *j* in segment *k*; *W2* is the average consumption wage per worker; and *M* is the structure of employment by skill (education) level of workers of type *j* in segment *k*.

The micro-simulation procedure assumes that workers move between occupational situations and economic sectors according to a random process in a normal distribution. Confidence intervals are generated using a Monte Carlo procedure. A more elaborate exposition of this procedure and the related assumptions is found in Ganuza, Barros and Vos (2002) and Vos et al. (2006). On the other hand, for the application of this micro-simulation methodology in a dynamic setting, a number of additional assumptions are required, as observed survey data are only available for the base year (and a few subsequent years eventually). In essence, we assume no demographic shifts (such as migration or population ageing) take place during the simulation period. This is an obvious limitation of the methodology but justifiable to the extent that the CGE model does not model or consider such demographic change either. Thus, we essentially take labor market outcomes from the CGE model scenarios to generate labor market structures for *t* periods (λ_t and λ_t^*) and apply them to a single micro dataset (for a given *t*).[15]

The micro-simulation methodology was implemented using the Living Standards Measurement Survey (LSMS) for 2001 from INEC. The CGE model provided baseline and simulation results for the parameters of the labour market structure for 2000-2004.[16] The changes of the labor market structure with respect to 2001 were imposed on the LSMS and this enabled us to generate poverty and inequality indicators for the baseline and the simulated scenarios. Before implementing this method, per capita household incomes were adjusted to be able to reproduce INEC's official poverty figures for 2001. These are produced by comparing per capita consumption rather than per capita income with respect to different total and extreme poverty lines. Two steps were followed. First, per capita household income was matched with per capita consumption for non-poor families whose per capita income was lower than their per

[15] Sánchez (2004) and Sánchez and Vos (2005 and 2006b) present a more detailed discussion of the implementation of the methodology in a dynamic setting and their limitations for the analysis.

[16] The participation rate is a constant in our CGE model and thus does not play a role in the micro-simulation analysis. The base-year unemployment rate by labor type is a constant in the model, too, but we changed it inversely (and proportionately) in response to changes in the employment rate by labor type in order to implement the micro-simulations.

capita consumption, and for poor families whose per capita income was above their per capita consumption. Secondly, for some families it was detected that labor incomes were larger than their total income, and the difference was imputed to total family income.

Our adjusted per capita household income is defined as:

$$ypc_h = \frac{1}{n_h}\left[\sum_{i=1}^{n_h} yp_{hi} + yq_h\right] \quad (3)$$

where n_h is the size of household h, yp_{hi} the labor income of member i of household h, and yq_h the sum of all non-labor incomes of the household, defined as:

$$yq_h = \sum_{i=1}^{n_h} yqp_{hi} + yqt_h \quad (4)$$

In equation (4), yqp_{hi} is individual non-labor income of member i of household h and yqt_h is other household incomes. In the simulations yp_{hi} is altered for some individuals i of household h as a result of changes in the labor market parameters.

Endogenous poverty lines produced by the CGE model were utilized to generate the poverty results, to account for the poverty effect of trade liberalization through the cost of basic consumption. The $1 and $2 a day poverty lines (in PPP)[17] were first calibrated, using the LSMS for 2001, to replicate INEC's official poverty figures for 2001. The calibrated, real poverty lines for 2001 were transformed into monetary poverty lines for all years in the simulation period (that is, 2000-2004). For this purpose we used the composite (consumption) price for each commodity from the CGE model (*PQ* in equation 4 in Appendix) which for all commodities was indexed to unity in 2001. For all other years the composite price of each commodity differs from one. The influence of the composite price of each commodity in the computation of the monetary poverty lines for all years of the simulation period was measured through commodity-based weights (that is, using the gamma parameter in the LES of the CGE model, see equation 34 in Appendix).

[17] We have used the international comparable poverty lines as previously defined by the World Bank. At the time of writing this paper, the new international poverty line estimates based on new PPP weights were not yet publicly available. See Chen and Ravallion (2008) for a discussion of the new poverty line estimates and the implications for trends in global poverty. We assume here that the directions of change in the poverty incidence for Nicaragua are not affected by the revised poverty line definition.

Liberalization scenarios

We are interested in assessing the impact of the removal of all forms of trade protection and farm price support measures in Nicaragua and in the rest of the world, particularly on the poor in Nicaragua. Since Nicaragua has eliminated most of its policies that were distorting agricultural incentives during the 1990s, further own-country liberalization is expected to have only a limited impact. The elimination of the much more substantial distortions in the rest of the world, especially in agriculture, could be more important for farmers in Nicaragua through the impact that would have on border prices for agricultural products.

To assess the welfare implications of various degrees of trade and domestic price liberalization in Nicaragua, resulting from unilateral and rest-of world reforms, four static simulations were performed and their impact is assessed through comparison with the two alternative baselines. The liberalization of trade is simulated through the removal of trade (import and export) taxes and subsidies for all tradable commodities and agricultural domestic supports.[18] The four simulations are the following:

trdlib1: unilateral liberalization of trade in agricultural commodities and domestic markets for agriculture;

trdlib2: unilateral liberalization of trade for all tradable commodities and for domestic markets for agriculture;

trdlib3: worldwide liberalization of trade in agricultural commodities and domestic markets for agriculture, that is, simulation *trdlib1* plus changes in export and import prices (terms-of-trade shocks) resulting from rest-of-world elimination of agricultural support measures; and

trdlib4: worldwide liberalization of trade in all tradable commodities and domestic prices for agriculture, that is, simulation *trdlib2* plus changes in export and import prices (terms-of-trade shock) resulting from rest-of-world liberalization of all trade, including the elimination of agricultural support measures.

[18] Non-agricultural commodities include highly processed food products (specifically, beverages and tobacco, which are GTAP sectors 25 and 26) and all other manufactures and non-farm primary goods.

Because Nicaragua has already liberalized most of its domestic agricultural markets, simulations *trdlib1* and *trdlib2* will reflect mainly the impact of removing remaining import tariffs. The worldwide trade liberalization scenarios (*trdlib3* and *trdlib4*) reflect in addition the effects on Nicaragua's export and import prices that such reform is expected to generate. All four scenarios are performed as static simulations as of 2004, because the Global Linkage model is calibrated with data for 2004. The base run of the model was calibrated such as to reproduce the agricultural protection structure consistent with that of the Global Linkage model.

Effects of agricultural and trade liberalization

The Global Linkage model's changes in Nicaragua's export and import prices, after simulating worldwide agricultural and non-agricultural trade liberalization relevant for simulations *trdlib3* and *trdlib4*, are shown in table 4. The border price changes are shown for the commodity breakdown of the Global Linkage model. For the present analysis, these were re-weighted to fit the commodity classification of Nicaragua's CGE model.[19] The table shows that both export and import prices would increase for most commodity groups. In the reclassified commodity groupings of the Nicaragua model, there would be a decline only for other manufactures in the scenario of worldwide trade liberalization for all goods (*trdlib4*). For virtually all other industries, the simulated worldwide liberalization would result in higher export and import prices for Nicaragua.

In the aggregate, Nicaragua's terms of trade would improve slightly by 0.3 and 1.2 percent in the global scenarios used as inputs for *trdlib3* and *trdlib4*, respectively. Table 5 shows that export prices would increase on average by 1.8 and 1.5 percent, respectively, in the two scenarios, while import prices would rise by, respectively, 1.3 and 0.3 percent. Resource allocation effects depend critically on the impact of trade liberalization on the real exchange rate

[19] Since Nicaragua's CGE model disaggregates trade by trading partner, the terms-of-trade shocks were further adapted using base-year trading partners' weighted participations in exports and imports from this model.

and domestic (consumer) prices. The real exchange rate appreciates in all scenarios: the more comprehensive the trade liberalization, the stronger the appreciation. The initial relative price shock favors exports more than import demand in all scenarios. Consequently, the (nominal) trade deficit narrows. Given the external closure rule that keeps foreign savings fixed, the exchange rate adjusts. The real exchange rate appreciation, of between 1 and 4 percent, causes positive second-round effects on import demand and negative effects on exports, weakening the final impact on the real trade balance. However, only in the simulations using the lower, country-specific Armington elasticities for the combined agricultural and non-agricultural price liberalization (*trdlib2* and *trdlib4*) does real import demand grow more than exports (table 5).

Domestic consumer prices unambiguously fall with respect to the baseline under all scenarios. As expected, the decline is stronger when both agricultural and non-agricultural commodities are liberalized and when the liberalization is global rather than just unilateral. The trade opening would also allow private consumption to grow, owing to the simulated decline in consumer prices. Private investment also expands in all scenarios (table 5).

Real exchange-rate appreciation tends to stimulate economic activity in Nicaragua. This outcome, which is embedded in the empirical structure of the country's CGE model, is due to the fact that production costs fall in the highly import-dependent Nicaraguan economy and the positive real wage effects under conditions of unemployment. While such stimulus is at work in the present scenarios, it appears that the relative price shifts resulting from the trade liberalization itself are equally important. Thus traditional exports (especially coffee and livestock), parts of manufacturing, construction and services expand in almost all scenarios, although to varying degrees (table 6). Farmers of basic grains lose under all scenarios as they see their protection fully dismantled. Important parts of manufacturing (sugar processing and other food processing) also suffer from trade opening in most scenarios, though less so when assuming the lower, country-specific Armington elasticities. Output in the EPZ suffers heavily in the scenarios with non-agricultural trade liberalization, as producers face rising costs of imported inputs (exacerbated by the exchange rate appreciation) and by the full exposure to global competition in the market for textiles and garments. That is, much of Nicaragua's *maquila* industry would lose its competitive edge without preferential market access and support measures. The relatively small industrial sectors with linkages to livestock production and

fishery (processed meats and fish, and dairy products) are among the winners in these liberalization scenarios.

In aggregate, the national economic welfare gains are modest, but they are somewhat larger when assuming the higher Armington elasticities from the Global Linkage model. In the latter case GDP increases by 0.3 percent compared with the baseline in the case of unilateral agricultural trade (*trdlib1),* and by 0.5 percent in the case of the unilateral removal of all price distortions under *trdlib2* (table 7). When using the lower, country-specific Armington elasticties, the output gains would be slightly higher: 0.4 and 0.8 percent, respectively. The difference is explained by the fact that with lower Armington elasticities the domestic consumer response to cheaper imports of basic grains and some manufactured food products is weaker than when Armington elasticities from the Global Linkage model are used. Output in basic grains and other manufacturing consequently suffer less (table 6). The direction of change is by and large the same under the scenarios with worldwide trade liberalization, but the effects are stronger since the Global Linkage model results suggests this would generate positive terms-of-trade effects for Nicaragua. Compared with the baseline, aggregate GDP would be 1.2 percent higher under *trdlib3* and 1.5 percent more in the case of *trdlib4* (table 5). Stronger import competition continues to affect farmers producing basic grains and some of the food processing, but the impact on this is less unfavourable compared with the scenarios of unilateral trade and domestic price liberalization (table 6). The welfare effects of worldwide trade liberalization are significantly lower, yet still positive, when using the lower, country-specific Armington elasticities. This is because the responsiveness of domestic producers to larger world demand for Nicaraguan exports and higher world market prices is weaker.

Fiscal cost of trade liberalization

The government closure rule of the model assumes a fixed fiscal deficit. Consequently, domestic tax rates need to adjust for any possible gains or losses in trade tax revenue in order to maintain the baseline fiscal balance. In the model, we provide for direct taxes to adjust (neutrally) to accommodate. Total government revenue falls initially in all trade liberalization scenarios.[20] As

[20] An alternative closure rule for the government would allow savings to fluctuate to balance the fiscal accounts and direct tax rates would be fixed at base-year levels. Under such a closure rule, government savings are found to

shown in figure 4, the fiscal costs are not trivial and would be almost 2 percent of GDP under *trdlib2* and *trdlib4*. The model simulations assume that the government is able to so raise enough extra direct taxes. Reducing trade barriers only gradually would make that more feasible, as under DR-CAFTA, and could also allow time to raise funds through public borrowing if needed in the short term.

Labor market effects

The potential productivity gains from trade openness are treated exogenously in the CGE model for Nicaragua. Hence, the simulated output gains from trade liberalization are materialized by the increased use of factors of production, especially labor. Employment and real labour incomes by and large follow the output effects. Aggregate employment would increase moderately in the unilateral trade liberalization scenarios (*trdlib1* and *trdlib2*) and slightly more when assuming lower trade elasticities. When using the higher Armington elasticities, around 20,000 jobs would be lost on farms producing basic grains and about 3,000 more in manufacturing in the case of unilateral agricultural liberalization (tables 7 and 8). Job losses in manufacturing and services would increase further to around 23,000 when also unilateral non-agricultural trade is liberalized, especially because of lower labor demand in the *maquila* EPZ. The unemployed workers find new employment opportunities in traditional export farming (coffee and livestock). Although this is not captured by the CGE model, this is unlikely to be a smooth adjustment. In the short run at least, frictional unemployment is likely to emerge given differences in skill requirements and location between the lost and the new jobs. When assuming the lower, country-specific Armington elasticities, employment effects (both positive and negative) are stronger (first rows of table 7).

Worldwide trade liberalization (*trdlib3* and *trdlib4*) would produce stronger employment effects in parallel with the stronger output effects. In essence, they would magnify the effects as observed under the unilateral trade liberalization scenario, but leave a proportionally larger net employment gain as job losses in basic grains farming are somewhat less under these scenarios.

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increase significantly to compensate for the elimination of revenues from import duties and taxes. In our analysis, however, we assume that there is some sort of fiscal discipline and the government can increase without limit the tax burden to keep its accounts in balance when trade taxes can no longer generate revenue.

Unskilled workers will see somewhat greater improvements in employment opportunities in most scenarios, especially for unskilled wage labourers in traditional agriculture and particularly when the liberalization is global (Table 7 and 8).

Nominal wage adjustment is assumed to be rather rigid in Nicaragua, given prevailing institutional wage-setting mechanisms in most sectors of the economy. For some types of workers in the CGE model's formal (wage-based) segment of the labor market, wages are partially indexed to year-to-year changes in consumer prices. Labor demand pressures influence movements in real wages, but only moderately and without clearing labor markets. Real consumption wages otherwise are strongly influenced by changes in consumer prices. As domestic prices fall for consumers under the trade liberalization scenarios relative to the baseline, real wages (labor incomes) increase under all scenarios. This is also consistent with the simulated appreciation of the real exchange rate. Real wage increases are similar across types of workers, although slightly stronger for unskilled workers as they would be in greater demand following further trade opening. Consistent with the results above, the real wage effects are stronger under economy-wide liberalization than when only agriculture is liberalized. Growth in the real wage of each worker is somewhat weaker under worldwide trade liberalization as compared with unilateral liberalization because employment grows more markedly under global liberalization.

Inequality and poverty effects

Despite the fact that employment growth favors unskilled workers in the trade opening scenarios, the estimated effect on inequality in the distribution of labour incomes and per capita household incomes is minimal (table 9). The Gini coefficient drops slightly by 0.003 points in the case of full-blown global liberalization of agricultural and non-agricultural commodities (*trdlib4*) and when using the high Armington elasticities. This is consistent with the stronger employment effects under that scenario. These inequality-reducing outcomes vanish, however, when using the lower, country-specific Armington elasticities and, in contrast, inequality drops – again slightly – under the unilateral trade liberalization scenarios. Employment effects are stronger in the model runs with the higher Armington elasticities and losses of jobs in low productivity smallholder farming of basic grains are offset by more jobs in higher-productivity export agriculture and job

losses in higher productivity and more skill-intensive industrial sectors. On the whole, though, the compounded effects of shifts in labor demand across skills and sectors produce very small distributional effects.

In consequence, the poverty effects are mainly driven by the average wage and employment effects. As table 9 shows, the poverty incidence falls in all scenarios and model runs, but typically by 1 percentage point or less (apart from one exception under *trdlib2* when using lower Armington elasticities). Such a modest impact on poverty is to be expected given the modest output and employment effects of trade liberalization. When assuming the lower, country-specific elasticities, rural poverty reduction is somewhat stronger amongst the extreme poor (that is, when using the $1-a-day poverty line). That can be explained by the lesser employment and real labor income losses for the poorest in traditional smallholder farming and income gains for the poorest in other agricultural activities. Urban poverty reduction is somewhat more significant amongst the moderately poor (those below a poverty line of $2 a day) who benefit more from the decline in consumer prices and the related increase in real consumption wages (relative to the baseline).

Along with the output and employment effects discussed above, poverty reduction tends to be slightly bigger when both agriculture and non-agricultural trade are liberalized. Yet with a drop in the poverty incidence by 1 percentage point or less, just around 22,000 extreme poor and 17,000 moderately poor are lifted out of poverty, leaving still an enormous challenge towards the goal of poverty eradication.[21]

Conclusions and policy implications

Nicaragua's agricultural sector is already close to free from import protection and price interventions, with few agricultural and agro-industrial products still highly protected from import competition. Under DR-CAFTA much of the country's trade with its major trading

[21] These findings are not dissimilar to those obtained for the expected impact of the regional trade agreement with the United States, DR-CAFTA, as analyzed in Sánchez and Vos (2006a, 2006b).

partner, the United States, will be near fully liberalized. In an ex-ante impact analysis, Sánchez and Vos (2006a, 2006b) show that openness under DR-CAFTA would yield positive overall welfare gains and poverty reduction effects but these, at best, will be very small and traditional agriculture and the rural poor are among the likely losers in the process. That analysis showed that only small welfare gains would be obtained from eliminating taxes on agricultural trade or from enhanced agro-industrial export quotas in trade with the United States, and most of the gains for Nicaragua would be obtained if the economy were able to fully utilize the greater market access granted for textile and clothing exports to the United States.

The present study has addressed the question as to whether further liberalization of trade with all trading partners would yield greater welfare outcomes and whether full and worldwide liberalization of policy barriers to the free flow of agricultural trade would contribute to poverty reduction in Nicaragua. The analysis confirms that small gains in terms of output and poverty reduction for Nicaragua may be expected under the various scenarios of trade opening considered here. The estimated effects are somewhat higher than those recorded in the 2006 Sánchez and Vos study, but at best aggregate output would increase by 1.5 percent and the reallocation of resources and labour market adjustment would have only a minimal impact on income inequality. Modest aggregate employment and real wage growth would contribute to poverty reduction, but at best by just 1 percentage point from still very high levels of extreme and moderate poverty. The extreme rural poor likely will gain somewhat more though, as much of the employment gains would be in the rural sector.

It is hardly surprising that we find such modest output gains and poverty reduction, given the fact that, at present, import tariffs are already low, most export taxes have been eliminated, and no direct farm-input subsidies exist. Furthermore, the gains for some sectors, especially traditional export agriculture (coffee, livestock) and the meat processing industry, would come at the expense of incomes and jobs for smallholder farmers. And export taxes that in 2004 were still levied on commodities such as vegetables and fruits, cattle sheep, and meats, have since been fully eliminated, hence the welfare gains from doing so have already materialized in practice. In consequence, additional gains in terms of output growth and poverty reduction from further trade liberalization for Nicaragua will likely be even more modest in practice than those reported in this chapter.

The fall in government revenue owing to the elimination of import duties and export taxes would be significant, ranging between 0.5 and 1.8 percent of GDP. The broadening of the tax base because of higher aggregate output following trade liberalization is unlikely in practice to be able to compensate for this, not least because it would be politically very controversial. An alternative could be for the government to finance the fiscal loss through increased public borrowing or aid inflows, but that too would be difficult given the country's already high indebtedness and its reliance on official development assistance. Thus a gradual approach to trade reform would be more desirable for fiscal reasons, but also to avoid labor market adjustment problems.

An additional cautionary remark about the simulation results presented in this chapter is their sensitivity to the chosen trade elasticity values. The higher trade responsiveness as assumed by the Global Linkage model of the World Bank tends to magnify output and employment gains (and losses) from trade liberalization compared with the use of relatively lower, country-specific elasticities that were estimated for Nicaragua by the authors. Should one consider the estimated elasticities to be more realistic, then the overall outcomes are even more modest.

Overall, the scenarios of agricultural and non-agricultural trade liberalization can be seen as a mixed blessing for Nicaragua's poor. If history is a guide, such measures when taken in isolation may not have a lasting impact on farm output growth or agricultural efficiency, as past liberalizations have only weakly impacted on the sector's productivity and dynamism. Bigger welfare gains will depend on complementary domestic policies directed at strengthening productivity growth and dynamic diversification of the agricultural sector and other sectors of the economy. Such policies could include improving rural infrastructure, access to credit, access to modern farm inputs, improved marketing and distribution systems, and more investment in human capital in rural areas. It would also require conducting prudent macroeconomic policies including keeping the exchange rate competitive and sustaining countercyclical fiscal and monetary stances. Domestic and international liberalization of markets for agricultural and other goods clearly do not present 'quick fixes' for Nicaragua's structural problems in developing a dynamic and diversified agricultural sector and reducing widespread poverty, particularly in rural areas.

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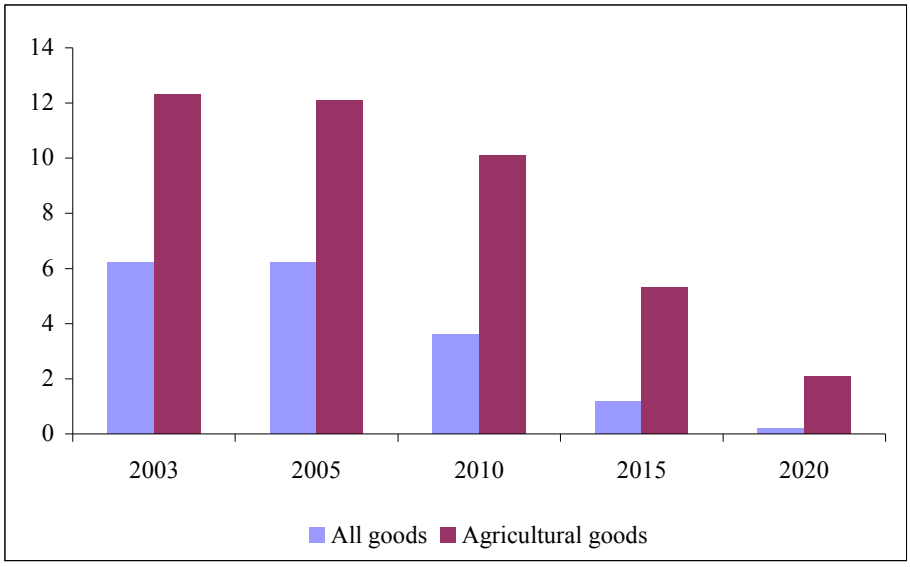
Figure 1: Weighted average tariff rate for agricultural and total imports from the United States as agreed under DR-CAFTA,[a] Nicaragua

(percent)

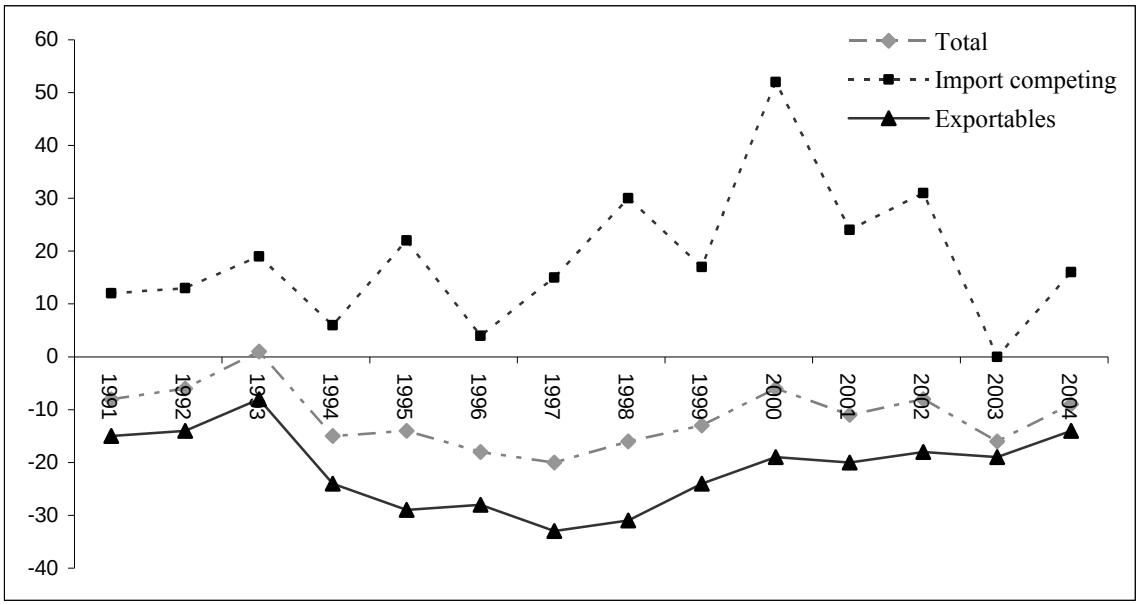


[a] DR-CAFTA was implemented immediately after it was ratified on October 10, 2005. Notice that the figures here refer to average nominal tariff rates, whereas the data in Figure 1 refer to effectively collected tariff revenues relative to the total value of imports.

Source: Authors' construction based on data from Sánchez and Vos (2006b, figure 2).

Figure 2: Nominal rate of assistance to exportable, importable, and all covered farm products, Nicaragua, 1991 to 2004

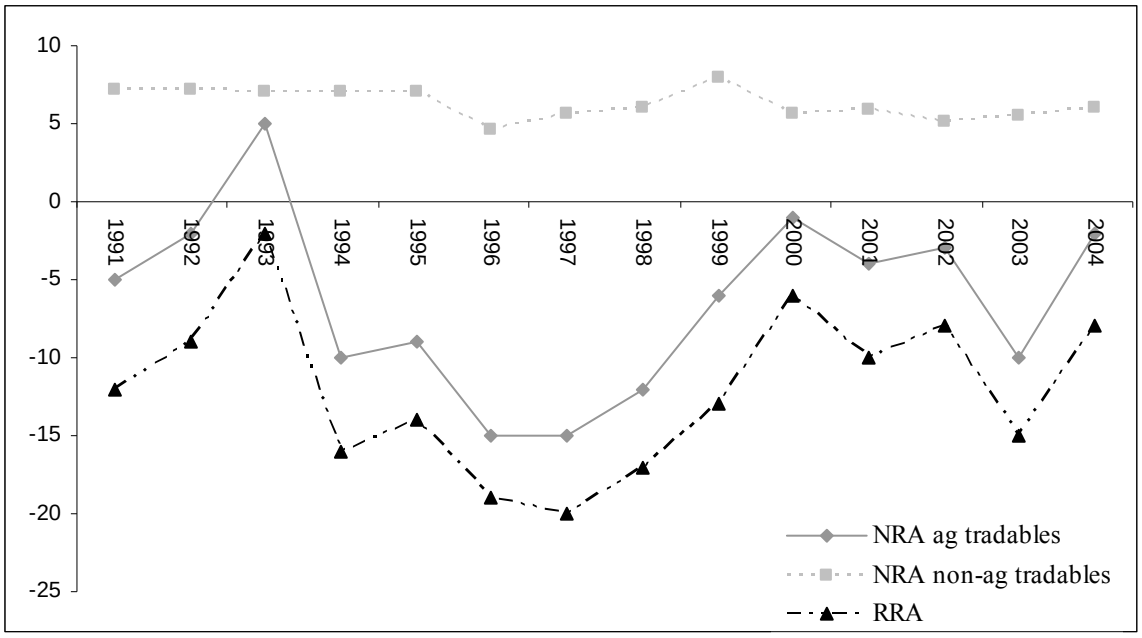
(percent)



Source: Berthelon, Kruger, and Saavedra **(**2008).

Figure 3: Nominal rate of assistance to agricultural and nonagricultural tradable sectors and relative rates of assistance for farmers, Nicaragua, 1991 to 2004

(percent)

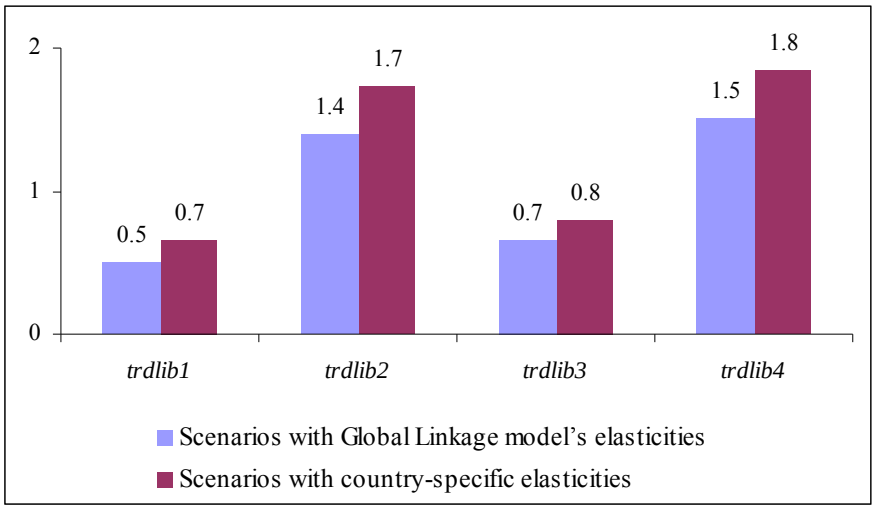


[a] The relative rate of assistance is defined as 100*[(100 + NRAag^t) / (100 + NRAnonag^t)) − 1], where *NRAag*^{t} and *NRAnonag*^{t} are the percentage NRAs for the tradables part of the agricultural and nonagricultural sectors, respectively.

Source: Berthelon, Kruger and Saavedra **(**2008).

Figure 4: Fiscal costs of trade liberalization, Nicaragua

(*deviation of tax revenue from the baseline scenario, percent of GDP*)



Source: Authors' Nicaraguan CGE model simulations.

Table 1: Macroeconomic indicators, Nicaragua, 1990 to 2005

(*annual averages*)

	1990-94	1995-99	2000-05
Average real wage (growth rate, %)[a]	-19.2	2.3	3.1
Inflation, consumer prices (annual percentage)	2,096.3	11.2	7.7
GDP (growth rate, %)	0.6	5.4	3.2
Agriculture	n.a.	4.6	4.0
Industry	n.a.	6.2	3.9
Services	n.a.	5.5	3.5
Employment (growth rate, %)	2.1	5.6	3.7
Exports plus imports as % of GDP	66.4	66.1	76.6
Exports of goods and services (% of GDP)	20.0	21.4	24.8
Traditional exports[b]			
- % of merchandise exports	73.9	52.7	37.2
- annual growth rate (%)	-1.8	10.8	6.9
Non-traditional exports			
- % of merchandise exports	26.1	47.3	62.8
- annual growth rate (%)	28.6	24.6	20.1
Non-traditional exports, excluding *maquila* 2/			
- % of merchandise exports	24.7	33.0	40.0
- annual growth rate (%)	16.6	17.5	12.1

[a] Data for the first period only cover 1991-1994.

[b] These include coffee, bananas, sugar, and bovine meat, cattle, seafood products (shrimp and lobster), sesame seeds, gold and silver.

Source: The World Bank (World Development indicators) for GDP, exports of goods and services, inflation and trade. All other data are from the Central Bank of Nicaragua.

Table 2: Structure of value added by sector at factor cost, Nicaragua, 1995 to 2004

(*percent*)

Sector	1995	2000	2004
Agriculture and light food processing	31.5	27.6	26.1
Agriculture[a]	23.4	20.9	17.8
Light food processing[b]	8.2	6.7	8.3
Mining and quarrying	0.7	0.8	1.4
Manufacturing	10.6	10.3	9.9
Electricity, gas and water supply	2.0	3.3	3.1
Construction	5.9	7.0	5.9
Services	49.2	50.9	53.7
TOTAL	100.0	100.0	100.0

[a] Including livestock, forestry and fishing.

[b] Processed food, excluding beverages and tobacco.

Source: Central Bank of Nicaragua, personal copmmunication.

Table 3: Poverty headcount ratios and Gini coefficient of income inequality, Nicaragua, 1993-2005

	1993	1998	2001	2005
Poverty headcount ratio at $1 a day[a]	44.0	42.2	43.0	39.4
Urban	26.0	24.9	27.5	22.3
Rural	69.2	62.8	64.7	60.7
Poverty headcount ratio at $2 a day[a]	74.0	77.8	78.0	75.8
Urban	61.2	66.1	67.0	63.0
Rural	92.0	91.6	93.3	91.9
Inequality of consumption (Gini coefficient)[b]	0.49	0.44	0.43	0.40
Urban	0.45	0.43	0.41	0.38
Rural	0.43	0.36	0.35	0.34
Inequality of income (Gini coefficient)[c]	0.58	0.58	0.58	n.a.
Urban	0.55	0.55	0.56	n.a.
Rural	0.54	0.56	0.51	n.a.

[a] Share of population whose consumption per capita is below the respective poverty line.

[b] For the distribution of per capita consumption.

[c] For the distribution of per capita household income.

Source: National Institute of Statistics and Censuses of Nicaragua except for the Gini coefficient for the distribution of per capita household income which is from ECLAC (2007).

Table 4: Trade structure and world price shocks imposed in the global trade liberalization simulations,[a] Nicaragua, 2004

	Sectoral shares of exports (%)	World export price (percentage change from 2004)		Sectoral shares of imports (%)	World import price (percentage change from 2004)	
		trdlib3	*trdlib4*		*trdlib3*	*trdlib4*
Paddy rice	0.00	0.00	0.00	1.39	9.66	8.52
Wheat	0.00	0.00	0.00	1.72	3.13	2.06
Other grains	0.00	0.00	0.00	0.48	17.64	16.42
Oil seeds	2.81	7.18	6.11	0.00	0.00	0.00
Vegetables and fruits	2.62	0.70	-0.18	0.31	4.55	2.62
Other crops	7.91	0.92	-0.12	0.26	9.15	7.17
Sugar cane and beet	0.00	0.00	0.00	0.00	0.00	0.00
Plant-based fibres	0.00	0.00	0.00	0.00	0.00	0.00
Other primary products	0.98	0.97	-2.21	4.46	2.09	-0.47
Cattle sheep	2.09	6.91	5.36	0.06	21.03	18.65
Other livestock	0.07	-0.11	-1.62	0.43	3.72	1.70
Raw milk	0.00	0.00	0.00	0.00	0.00	0.00
Wool	0.00	0.00	0.00	0.00	0.00	0.00
Beef and sheep meat	6.88	6.04	4.97	0.34	3.12	2.02
Other meat products	0.14	10.21	8.98	0.17	7.74	5.92
Vegetable oils and fats	0.59	-1.19	-1.77	2.58	1.29	-0.08
Processed rice	0.00	0.00	0.00	0.16	1.11	-0.07
Dairy products	1.86	2.39	0.99	0.30	7.72	5.82
Refined sugar	2.24	6.44	5.21	0.00	0.00	0.00
Other food, beverages and tobacco	8.97	0.22	2.85	6.74	1.42	1.15
Textile and wearing apparel	35.59	0.75	1.94	13.87	0.63	0.21
Other manufactured goods	13.07	0.48	-2.11	56.30	1.02	0.01
Services	14.18	0.22	-0.20	10.42	0.16	-0.36

[a] The four simulations are:
Trdlib1: unilateral liberalization of agricultural commodity markets;
trdlib2: unilateral liberalization of trade for all tradable commodities;
trdlib3: global liberalization of agricultural commodity markets; and
trdlib4: global liberalization of trade for all tradable commodities.

Source: Linkage model simulations (see Anderson, Valenzuela and van der Mensbrugghe 2010).

Table 5: Impact of prospective trade liberalizations[b] on the macroeconomy,[b] Nicaragua, 2004

(*percentage deviation from the baseline*)

	trdlib1	*trdlib2*	*trdlib3*	*trdlib4*
GDP (factor cost)				
Scenarios with Global Linkage model's elasticities	0.3	0.5	1.2	1.5
Scenarios with country-specific elasticities	0.4	0.8	0.7	1.1
Private consumption				
Scenarios with Global Linkage model's elasticities	1.1	1.6	1.7	2.7
Scenarios with country-specific elasticities	0.8	1.5	0.9	2.0
Fixed investment				
Scenarios with Global Linkage model's elasticities	1.1	3.4	1.4	4.7
Scenarios with country-specific elasticities	0.9	3.1	0.9	3.8
Exports				
Scenarios with Global Linkage model's elasticities	6.9	10.0	11.6	14.1
Scenarios with country-specific elasticities	2.1	4.0	3.8	5.0
Imports				
Scenarios with Global Linkage model's elasticities	4.5	7.5	6.4	10.0
Scenarios with country-specific elasticities	1.9	4.3	2.6	5.2
Real exchange rate				
Scenarios with Global Linkage model's elasticities	-1.4	-2.8	-3.6	-4.6
Scenarios with country-specific elasticities	-1.2	-3.1	-3.2	-4.4
World export price				
Scenarios with Global Linkage model's elasticities	0.0	0.0	1.8	1.5
Scenarios with country-specific elasticities	0.0	0.0	1.8	1.5
World import price				
Scenarios with Global Linkage model's elasticities	0.0	0.0	1.3	0.3
Scenarios with country-specific elasticities	0.0	0.0	1.3	0.3
Terms of trade				
Scenarios with Global Linkage model's elasticities	0.0	0.0	0.3	1.2
Scenarios with country-specific elasticities	0.0	0.0	0.3	1.2
Consumer price index				
Scenarios with Global Linkage model's elasticities	-0.8	-1.5	-0.9	-1.7
Scenarios with country-specific elasticities	-0.7	-1.4	-0.8	-1.5

[a] The four simulations are:
Trdlib1: unilateral liberalization of agricultural commodity markets;
trdlib2: unilateral liberalization of trade for all tradable commodities;
trdlib3: global liberalization of agricultural commodity markets; and
trdlib4: global liberalization of trade for all tradable commodities.
[b] Real government consumption is assumed to be fixed in the model such that this variable is not expected to change with respect to the baseline in the scenarios of trade liberalization.

Source: Authors' Nicaraguan CGE model simulations.

Table 6: Impact of prospective trade liberalization on real sectoral GDP, Nicaragua

(percent)

Sector	Share of base-year (2000) real GDP	Percentage deviation from the baseline scenario[a]			
		trdlib1	*trdlib2*	*trdlib3*	*trdlib4*
Coffee					
Scenarios with Global Linkage model's elasticities	3.2	8.6	17.8	28.0	41.4
Scenarios with country-specific elasticities	3.2	2.6	7.1	8.3	12.9
Sugar cane					
Scenarios with Global Linkage model's elasticities	0.9	0.3	1.3	-1.9	-0.4
Scenarios with country-specific elasticities	0.9	0.0	0.1	-0.7	-0.5
Basic grains					
Scenarios with Global Linkage model's elasticities	3.9	-7.4	-7.7	-5.6	-5.9
Scenarios with country-specific elasticities	3.9	-2.4	-2.5	-1.7	-1.7
Other agricultural production					
Scenarios with Global Linkage model's elasticities	4.0	1.0	2.6	5.6	7.2
Scenarios with country-specific elasticities	4.0	0.4	1.0	1.1	1.8
Livestock farming					
Scenarios with Global Linkage model's elasticities	6.0	2.4	6.9	1.4	6.5
Scenarios with country-specific elasticities	6.0	0.6	2.6	-0.2	1.8
Forestry, logging and related service activities					
Scenarios with Global Linkage model's elasticities	1.1	0.0	-0.6	0.7	0.5
Scenarios with country-specific elasticities	1.1	0.2	0.4	0.4	1.0
Fishing					
Scenarios with Global Linkage model's elasticities	1.5	2.7	7.2	1.6	6.6
Scenarios with country-specific elasticities	1.5	0.7	2.7	0.0	2.0
Mining and quarrying					
Scenarios with Global Linkage model's elasticities	0.8	-0.7	-1.4	-1.6	-3.0
Scenarios with country-specific elasticities	0.8	-0.7	-0.9	0.3	0.5
Production, processing and preservation of meat and fish					
Scenarios with Global Linkage model's elasticities	1.8	4.8	13.6	2.7	12.1
Scenarios with country-specific elasticities	1.8	1.2	4.7	-0.3	3.0
Production, processing and preservation of sugar					
Scenarios with Global Linkage model's elasticities	1.0	-0.2	0.3	-2.8	-2.0
Scenarios with country-specific elasticities	1.0	-0.3	-0.8	-1.3	-1.7
Manufacture of dairy products					
Scenarios with Global Linkage model's elasticities	1.0	-0.8	-0.5	1.1	1.8
Scenarios with country-specific elasticities	1.0	0.2	0.4	0.3	0.6

Table 6 (continued)

Sector	Participation in base-year (2000) real GDP	Percentage deviation from the baseline scenario[a]			
		trdlib1	*trdlib2*	*trdlib3*	*trdlib4*
Manufacture of other food products					
Scenarios with Global Linkage model's elasticities	2.2	-6.3	-7.0	-6.6	-7.6
Scenarios with country-specific elasticities	2.2	-0.5	-0.6	-0.5	-0.4
Zona Franca (export-processing free zone)					
Scenarios with Global Linkage model's elasticities	1.4	3.6	-23.8	10.6	-24.4
Scenarios with country-specific elasticities	1.4	0.9	-10.3	2.9	-11.1
Other manufacturing					
Scenarios with Global Linkage model's elasticities	8.1	0.0	0.0	0.0	0.0
Scenarios with country-specific elasticities	8.1	0.0	0.0	0.0	0.0
Electricity, gas and water supply					
Scenarios with Global Linkage model's elasticities	3.1	0.1	-0.4	0.2	-0.3
Scenarios with country-specific elasticities	3.1	0.1	-0.1	0.2	0.0
Construction					
Scenarios with Global Linkage model's elasticities	7.8	0.4	1.7	0.5	2.3
Scenarios with country-specific elasticities	7.8	0.4	1.5	0.3	1.8
Services					
Scenarios with Global Linkage model's elasticities	52.3	0.0	-0.3	0.6	0.4
Scenarios with country-specific elasticities	52.3	0.0	0.3	0.3	0.6

[a] The four simulations are:
Trdlib1: unilateral liberalization of agricultural commodity markets;
trdlib2: unilateral liberalization of trade for all tradable commodities;
trdlib3: global liberalization of agricultural commodity markets; and
trdlib4: global liberalization of trade for all tradable commodities.

Source: Authors' Nicaraguan CGE model simulations.

Table 7: Impact of prospective trade liberalization on employment and real wages, Nicaragua (*percentage deviation from the baseline scenario*)[d]

	Employment				Real consumption wage (per worker)			
	trdlib1	*trdlib2*	*trdlib3*	*trdlib4*	*trdlib1*	*trdlib2*	*trdlib3*	*trdlib4*
Total								
Scenarios with Global Linkage model's elasticities	0.1	0.7	1.8	2.7	1.4	2.2	0.8	1.6
Scenarios with country-specific elasticities	0.4	1.2	1.1	1.9	0.9	1.8	0.8	1.7
Skilled workers [a]								
Scenarios with Global Linkage model's elasticities	0.4	0.8	1.6	2.1	1.0	1.8	0.8	1.6
Scenarios with country-specific elasticities	0.4	1.0	0.8	1.4	0.9	1.7	0.9	1.8
Unskilled workers [b]								
Scenarios with Global Linkage model's elasticities	0.0	0.7	2.0	3.0	1.6	2.5	0.9	1.8
Scenarios with country-specific elasticities	0.4	1.3	1.2	2.2	1.0	1.9	0.8	1.8
Wage labor								
Scenarios with Global Linkage model's elasticities	0.7	0.2	2.3	1.9	0.8	1.7	0.3	1.1
Scenarios with country-specific elasticities	0.6	1.0	1.3	1.7	0.7	1.5	0.6	1.5
Non-wage labor [c]								
Scenarios with Global Linkage model's elasticities	-0.3	1.1	1.5	3.2	1.8	2.9	1.2	2.4
Scenarios with country-specific elasticities	0.3	1.4	0.9	2.1	1.1	2.1	0.9	2.0

[a] Skill workers have completed 9 or more years of formal education and can be employed in wage or non-wage segments of the labor market.
[b] Unskilled workers have completed 8 or less years of formal education and can be employed in wage or non-wage segments of the labor market.
[c] Non-wage labor is self-employed workers.
[d] The four simulations are:
Trdlib1: unilateral liberalization of agricultural commodity markets;
trdlib2: unilateral liberalization of trade for all tradable commodities;
trdlib3: global liberalization of agricultural commodity markets; and
trdlib4: global liberalization of trade for all tradable commodities.

Source: Authors' Nicaraguan CGE model simulations.

Table 8: Impact of prospective trade liberalization on employment, by sector, Nicaragua

Sector	*Base employment level (2004)* [a]	*Percentage deviation from the baseline scenario*[b]			
		trdlib1	*trdlib2*	*trdlib3*	*trdlib4*
Coffee					
Scenarios with Global Linkage model's elasticities	139,286	8.2	16.9	27.3	40.0
Scenarios with country-specific elasticities	139,286	2.3	6.4	7.9	12.0
Sugar cane					
Scenarios with Global Linkage model's elasticities	18,406	0.0	0.7	-2.4	-1.3
Scenarios with country-specific elasticities	18,406	-0.2	-0.4	-1.0	-1.2
Basic grains					
Scenarios with Global Linkage model's elasticities	255,238	-7.5	-7.9	-5.8	-6.2
Scenarios with country-specific elasticities	255,238	-2.5	-2.7	-1.8	-1.9
Other agricultural production					
Scenarios with Global Linkage model's elasticities	194,881	0.6	1.9	5.0	6.2
Scenarios with country-specific elasticities	194,881	0.1	0.4	0.8	1.1
Livestock farming					
Scenarios with Global Linkage model's elasticities	230,694	1.9	6.0	0.8	5.3
Scenarios with country-specific elasticities	230,694	0.3	1.9	-0.6	0.9
Forestry, logging and related service activities					
Scenarios with Global Linkage model's elasticities	46,828	-0.4	-1.3	0.2	-0.5
Scenarios with country-specific elasticities	46,828	-0.1	-0.2	0.1	0.3
Fishing					
Scenarios with Global Linkage model's elasticities	25,395	4.8	13.5	2.7	12.4
Scenarios with country-specific elasticities	25,395	1.4	5.2	0.0	3.9
Mining and quarrying					
Scenarios with Global Linkage model's elasticities	16,785	-2.1	-4.1	-4.8	-8.6
Scenarios with country-specific elasticities	16,785	-1.3	-1.6	0.5	0.9
Production, processing and preservation of meat and fish					
Scenarios with Global Linkage model's elasticities	34,479	4.4	12.6	2.0	10.7
Scenarios with country-specific elasticities	34,479	0.8	3.9	-0.8	2.0
Production, processing and preservation of sugar					
Scenarios with Global Linkage model's elasticities	5,239	-0.4	-0.1	-3.1	-2.5
Scenarios with country-specific elasticities	5,239	-0.5	-1.2	-1.5	-2.1
Manufacture of dairy products					
Scenarios with Global Linkage model's elasticities	23,543	-1.3	-1.5	0.4	0.4
Scenarios with country-specific elasticities	23,543	-0.1	-0.5	-0.2	-0.4

Table 8 (continued)

Sector	*Base employment level (2004)* [a]	*Percentage deviation from the baseline scenario* [b]			
		trdlib1	*trdlib2*	*trdlib3*	*trdlib4*
Manufacture of other food products					
Scenarios with Global Linkage model's elasticities	67,684	-6.8	-7.8	-7.2	-8.8
Scenarios with country-specific elasticities	67,684	-0.9	-1.4	-0.9	-1.4
Zona Franca (export-processing free zone)					
Scenarios with Global Linkage model's elasticities	41,275	0.0	-0.2	0.1	-0.2
Scenarios with country-specific elasticities	41,275	0.0	-0.1	0.0	-0.1
Other manufacturing					
Scenarios with Global Linkage model's elasticities	88,082	-0.5	-4.2	-0.1	-4.2
Scenarios with country-specific elasticities	88,082	-0.2	-1.3	-0.1	-1.3
Electricity, gas and water supply					
Scenarios with Global Linkage model's elasticities	13,967	-0.2	-0.9	-0.2	-1.1
Scenarios with country-specific elasticities	13,967	-0.1	-0.5	-0.1	-0.6
Construction					
Scenarios with Global Linkage model's elasticities	99,168	-0.1	0.6	-0.3	0.7
Scenarios with country-specific elasticities	99,168	0.0	0.5	-0.2	0.6
Services					
Scenarios with Global Linkage model's elasticities	824,451	0.0	-0.7	0.3	-0.5
Scenarios with country-specific elasticities	824,451	0.2	0.0	0.3	0.2

[a] Number employed.

[b] The four simulations are:
Trdlib1: unilateral liberalization of agricultural commodity markets;
trdlib2: unilateral liberalization of trade for all tradable commodities;
trdlib3: global liberalization of agricultural commodity markets; and
trdlib4: global liberalization of trade for all tradable commodities.

Source: Authors' Nicaraguan CGE model simulations.

Table 9: Micro-simulation results for poverty and inequality, Nicaragua

	Poverty headcount ratio at $1 a day (%)			Poverty headcount ratio at $2 a day (%)			Gini Coefficient	
	Total	Urban	Rural	Total	Urban	Rural	Labour income	Per capita household income
Scenarios with Global Linkage model's elasticities								
baseline, 2001[a]	42.9	27.5	64.4	77.9	67.7	92.3	0.569	0.536
baseline, 2004	41.4	26.0	63.0	72.1	59.7	89.6	0.568	0.531
trdlib1, 2004	41.3	26.3	62.3	71.8	59.6	88.9	0.568	0.530
deviation from the baseline [b]	*-0.1*	*0.3*	*-0.7*	*-0.4*	*-0.1*	*-0.7*	*0.000*	*-0.001*
trdlib2, 2004	40.5	25.3	61.7	71.5	59.0	89.0	0.566	0.529
deviation from the baseline [b]	*-1.0*	*-0.7*	*-1.3*	*-0.6*	*-0.7*	*-0.6*	*-0.002*	*-0.002*
trdlib3, 2004	41.2	25.8	62.6	71.7	59.2	89.2	0.567	0.532
deviation from the baseline [b]	*-0.3*	*-0.2*	*-0.4*	*-0.4*	*-0.4*	*-0.4*	*-0.001*	*0.000*
trdlib4, 2004	41.0	26.3	61.7	71.6	59.2	89.0	0.565	0.529
deviation from the baseline [b]	*-0.4*	*0.2*	*-1.3*	*-0.5*	*-0.4*	*-0.6*	*-0.003*	*-0.003*
Scenarios with country-specific elasticities								
baseline, 2001[a]	42.9	27.5	64.4	77.9	67.7	92.3	0.569	0.536
baseline, 2004	42.0	27.2	62.8	72.0	59.7	89.2	0.571	0.534
trdlib1, 2004	41.1	26.0	62.3	71.3	58.5	89.2	0.567	0.531
deviation from the baseline [b]	*-0.8*	*-1.1*	*-0.5*	*-0.7*	*-1.2*	*-0.1*	*-0.003*	*-0.003*
trdlib2, 2004	40.5	25.7	61.1	71.4	59.0	88.7	0.568	0.531
deviation from the baseline [b]	*-1.5*	*-1.4*	*-1.6*	*-0.6*	*-0.7*	*-0.5*	*-0.003*	*-0.003*
trdlib3, 2004	41.7	27.0	62.2	72.0	59.6	89.3	0.571	0.533
deviation from the baseline [b]	*-0.3*	*-0.2*	*-0.6*	*-0.1*	*-0.1*	*0.1*	*0.000*	*0.000*
trdlib4, 2004	41.1	26.7	61.2	71.1	58.4	88.9	0.571	0.534
deviation from the baseline [b]	*-0.9*	*-0.5*	*-1.5*	*-0.9*	*-1.3*	*-0.3*	*0.001*	*0.000*

[a] The use of different Armington elasticities does not affect the results for 2001 in the baseline scenario because, in the application of the micro-simulations, all changes in the labor market are seen relative to 2001, the year for which the LSMS that was used was conducted.

[b] Differences are expressed as absolute deviations (points or percentage points) from baseline.

Source: Authors' Nicaraguan CGE model results and micro-simulations.

Appendix: Mathematical summary of the CGE model for Nicaragua[22]

Sets

$a \in A$	Activities
$a \in AK(\subset A)$	activities hiring capital
$a \in ALMO(\subset A)$	activities hiring mobile labour (all except fishing and mining)
$a \in ALNMO(\subset A)$	activities hiring non-mobile labour (only fishing and mining)
$a \in APU(\subset A)$	public and utility sector activities
$a \in APULMO(\subset A)$	public and utility sector activities hiring mobile labour
$a \in APULNMO(\subset A)$	public and utility sector activities hiring non-mobile labour
$c \in C$	commodities
$c \in CD(\subset C)$	commodities with domestic sales of domestic output
$c \in CDN(\subset C)$	commodities without domestic sales of domestic output
$c \in CE(\subset C)$	exported commodities (with domestic production)
$c \in CEN(\subset C)$	non-exported commodities (complement of *CE*)
$c \in CM(\subset C)$	imported commodities (with domestic production)
$c \in CMN(\subset C)$	non-imported commodities (complement of *CM*)
$c \in CT(\subset C)$	transaction service commodities
$c \in CX(\subset C)$	commodities with domestic production
$f \in F$	factors
$f \in K(\subset F)$	capital
$f \in L(\subset F)$	labour
$f \in LSK(\subset L)$	skilled labour
$f \in LUSK(\subset L)$	unskilled labour
$f \in LWASK(\subset L)$	skilled wage labour
$f \in LWAUSK(\subset L)$	unskilled wage labour
$f \in LMO(\subset L)$	mobile labour demanded by all activities but fishing and mining
$f \in LNMO(\subset L)$	non-mobile labour demanded only by fishing and mining activities
$i \in INS$	institutions
$i \in INSD(\subset INS)$	domestic institutions
$i \in INSDNG(\subset INSD)$	domestic non-government institutions

[22] In this Appendix, Greek and lower-case letters (with or without bar) refer to parameters and elasticities, and upper-case Roman letters refer to endogenous variables (without bar) or exogenous variables (with bar). Subscripts either represent the domain (activities, commodities, factors, or institutions) or indicate current or past period (*t* or *t*-1, respectively).

$i \in INSND(\subset INS)$	rest of the world
$r \in R(\subset INSND)$	partners of the rest of the world
$h \in H(\subset INSDNG)$	households

Model parameters and variables

Parameters	
$\overline{capsh}_{ka}$	activity share of aggregate capital income
$cwts_c$	weight of commodity *c* in the *CPI*
$\overline{d}$	capital depreciation rate (economy-wide)
$dwts_c$	weight of commodity *c* in the producer price index
ica_{ca}	quantity of commodity *c* per unit of aggregate intermediate input used in activity *a*
$icd_{cc'}$	quantity of commodity *c* as trade input per unit of *c'* produced and sold domestically
$ice_{cc'}$	quantity of commodity *c* as trade input per exported unit of *c'*
$icm_{cc'}$	quantity of commodity *c* as trade input per imported unit of *c'*
$inadj_{la}$	wage adjustment factor with respect to consumer price changes for labour type *l* in activity *a*
$inta_a$	quantity of aggregate intermediate input per activity unit
$\overline{lfgr}_l$	labour force growth rate for labour type *l*
mps_i	marginal propensity to save for domestic non-government institution *i*
pwe_{rc}	world export price of commodity *c* for trading partner *r* (foreign currency)
$qdst_c$	quantity of inventory (stock) change
$\overline{qinv}_c$	base-year quantity of investment demand by commodity *c*
$\overline{qinvsh}_c$	shares of investment goods in the aggregate capital
$shif_{if}$	share for domestic institution *i* in income of factor *f*
$shii_{ii'}$	share of net income of *i'* to *i* (*i'* $\in$ *INSDNG'*; *i* $\in$ INSDNG)
ta_a	indirect tax rate for activity *a*
te_{rc}	export tax rate for exported commodity *c* for trading partner *r*
$\overline{tins}_i$	exogenous direct tax rate for domestic institution *i*
tm_{rc}	import tariff rate for imported commodity *c* for trading partner *r*
tq_c	rate of sales tax for commodity *c*
$trnsfr_{if}$	transfers from institution *i* to factor *f*
$trnsfr_{fi}$	transfers from factor *f* to institution *i*

tva_a	rate of value-added tax for activity *a*
α_a^a	CES activity-function efficiency parameter
α_c^e	CET function shift parameter
α_{cr}^e	export-demand function shift parameter
α_c^m	*Armington* function shift parameter
α_a^{va}	efficiency parameter in the CES value-added function
β_{ch}	marginal-budget share of consumption spending on commodity *c* for household *h*
δ_a^a	CES activity-function share parameter
δ_c^e	CET function share parameter
δ_c^m	*Armington* function share parameter
δ_{fa}^{va}	CES value-added function share parameter for factor *f* in activity *a*
γ_{ch}	subsistence consumption of marketed commodity *c* for household *h*
κ	mobility of investable funds parameter
θ_{ac}	yield of output *c* per unit of activity *a*
ρ_a^a	CES activity function exponent
ρ_c^e	CET function exponent
ρ_{cr}^e	export-demand function exponent
ρ_c^m	*Armington* function exponent
ρ_a^{va}	CES value-added function exponent

Exogenous variables

$\overline{DPI}$	producer price index for domestically marketed output
$\overline{FDI}$	autonomous foreign direct investment
$\overline{FSAV}$	foreign savings
$\overline{GSAV}$	government savings
$\overline{KFLOW}$	net capital inflows from the rest of the world
$\overline{PWM}_{rc}$	world import price of commodity *c* for trading partner *r* (foreign currency)
$\overline{QF}_{fa}$	quantity demanded of factor *f* in activity *a* (for capital in first within-period solution and for non-mobile labour in all within-period solutions)
$\overline{QG}_c$	government consumption demand for commodity *c*
$\overline{WF}_f$	economy-wide wage for factor *f* (for capital in first within-period solution and for labour in all within-period solutions)
$\overline{WFDIST}_{fa}$	wage-distortion factor for factor *f* in activity *a* (for capital after first within-period solution and for mobile labour in all within-period solutions)

Endogenous variables

CPI	consumer price index
EG	government expenditure
EH_h	consumption expenditure in household *h*

EXR	exchange rate (local currency per unit of foreign currency)
$IADJ$	investment adjustment factor
EH_h	activity-shares of investable funds (after first within-period solution)
$IREAL_f$	aggregate real investment in (capital) factor *f*
$IREALAC_{fa}$	real investment in (capital) factor *f* by sector (activity) of destination (after first within-period solution)
KGR_f	period growth rate of aggregate (capital) factor stock (after first within-period solution)
$KGRAC_{fa}$	period growth rate of sectoral (capital) factor stock (after first within-period solution)
PA_a	activity price (gross revenue per unit of activity)
PDD_c	demand price for commodity *c* produced and sold domestically
PDS_c	supply price for commodity *c* produced and sold domestically
PE_{rc}	domestic export price for commodity *c* for trading partner *r* (domestic currency)
$PINTA_a$	aggregate intermediate input price for activity *a*
PK	aggregate capital good price
PM_{cr}	domestic import price for commodity *c* for trading partner *r* (domestic currency)
PQ_c	composite price for commodity *c* (including commodity tax)
PVA_a	aggregate value-added price for activity *a*
PW_{cr}	average world price of commodity *c* for trading partner *r*
PX_c	producer price for commodity *c*
$PXAC_{ac}$	activity specific commodity price
QA_a	quantity of activity *a*
QD_c	quantity of domestic output *c* sold domestically
QE_{rc}	quantity of exports of commodity *c* for trading partner *r*
QF_{fa}	quantity demanded of factor *f* in activity *a* (for capital after first within-period solution and for mobile labour in all within-period solutions)
QFS_f	quantity supplied of factor *f*
QH_{ch}	quantity of consumption of marketed commodity *c* for household *h*
$QINTA_a$	quantity of aggregate intermediate input in activity *a*
$QINT_{ca}$	quantity of commodity *c* as intermediate input to activity *a*
$QINV_c$	quantity of investment demand for commodity *c*
QM_{cr}	quantity of imports of commodity *c* for trading partner *r*
QQ_c	quantity of composite good *c* supplied to the domestic market
QT_c	quantity of commodity *c* demanded as trade input
QVA_a	quantity of aggregate value-added in activity *a*
QX_c	aggregate quantity of domestic output of commodity *c*
$QXAC_{ac}$	marketed output quantity of commodity *c* from activity *a*
$TINS_i$	rate of direct tax on domestic institution *i*

$TINSADJ$	direct tax scaling factor
$TRII_{ii'}$	transfers from institution *i'* to institution *i*
WF_f	economy-wide wage for factor *f* (for capital after first within-period solution)
$WFDIST_{fa}$	wage-distortion factor for factor *f* in activity *a* (for capital in first within-period solution and for non-mobile labour in all within-period solutions)
$WFDISTK_{ka}$	activity-shares of average economy-wide rental on all capital
$WFKAV_k$	average economy-wide rental on all capital
$WFREAL_f$	economy-wide real consumption wage of factor *f*
YF_f	income of factor *f*
YG	government revenue
YI_i	income of non-government institution *i*
YIF_{if}	income transferred to domestic institution *i* from factor *f*

Model equation blocks

Price system block

$PM_{rc} = pwm_{rc} \cdot EXR \cdot (1 + tm_{rc}) + \sum_{c' \in CT} PQ_{c'} \cdot icm_{c'c}$	$c \in CM$, $r \in R$	(1)
$PE_{cr} = pwe_{cr} \cdot EXR \cdot (1 - te_{cr}) + \sum_{c' \in CT} PQ_c \cdot ice_{c'c}$	$c \in CE$, $r \in R$	(2)
$PDD_c = PDS_c + \sum_{c' \in CT} PQ_{c'} \cdot icd_{c'c}$	$c \in CD$	(3)
$PQ_c \cdot (1 - tq_c) \cdot QQ_c = PDD_c \cdot QD_c + \sum_{r \in R} (PM_{rc} \cdot QM_{rc})$	$c \in (CD \cup CM)$	(4)
$PX_c \cdot QX_c = PDS_c \cdot QD_c + \sum_{r \in R} (PE_{cr} \cdot QE_{cr})$	$c \in CX$	(5)
$PA_a = \sum_{c \in C} PXAC_{ac} \cdot \theta_{ac}$	$a \in A$	(6)
$PINTA_a = \sum_{c \in C} PQ_c \cdot ica_{ca}$	$a \in A$	(7)
$PA_a \cdot (1 - ta_a) \cdot QA_a = PVA_a \cdot QVA_a + PINTA_a \cdot QINTA_a$	$a \in A$	(8)
$CPI = \sum_{c \in C} PQ_c \cdot cwts_c$		(9)
$\overline{DPI} = \sum_{c \in C} PDS_c \cdot dwts_c$		(10)

Production technology block

$QA_a = \alpha_a^a \cdot \left(\delta_a^a \cdot QVA_a^{-\rho_a^a} + (1 - \delta_a^a) \cdot QINTA_a^{-\rho_a^a} \right)^{-\frac{1}{\rho_a^a}}$	$a \in A$	(11)
$\frac{QVA_a}{QINTA_a} = \left(\frac{PINTA_a}{PVA_a} \cdot \frac{\delta_a^a}{1 - \delta_a^a} \right)^{\frac{1}{1 + \rho_a^a}}$	$a \in A$	(12)

$QVA_a = \alpha_a^{va} \cdot \left(\sum_{f \in F} \delta_{fa}^{va} \cdot \overline{QF}_{fa}^{-\rho_a^{va}} \right)^{-\frac{1}{\rho_a^{va}}}$	$a \in (AK \cup ALNMO)$	(13a)
$QVA_a = \alpha_a^{va} \cdot \left(\sum_{f \in F} \delta_{fa}^{va} \cdot QF_{fa}^{-\rho_a^{va}} \right)^{-\frac{1}{\rho_a^{va}}}$	$a \in ALMO$	(13b)
$QINT_{ca} = ica_{ca} \cdot QINTA_a$	$a \in A$, $c \in C$	(14)
$\overline{WF}_f \cdot WFDIST_{fa} =$ $PVA_a \cdot (1 - tva_a) \cdot QVA_a \cdot \left(\sum_{f \in F} \delta_{fa}^{va} \cdot \overline{QF}_{fa}^{-\rho_a^{va}} \right)^{-1} \cdot \delta_{fa}^{va} \cdot \overline{QF}_{fa}^{-\rho_a^{va}-1}$	$a \in (AK \cup ALNMO)$, $f \in (K \cup LNMO)$	(15a)
$\overline{WF}_f \cdot \overline{WFDIST}_{fa} =$ $PVA_a \cdot (1 - tva_a) \cdot QVA_a \cdot \left(\sum_{f \in F} \delta_{fa}^{va} \cdot QF_{fa}^{-\rho_a^{va}} \right)^{-1} \cdot \delta_{fa}^{va} \cdot QF_{fa}^{-\rho_a^{va}-1}$	$a \in ALMO$, $f \in LMO$	(15b)
$WFKAV_f = \sum_{a \in A} \left(\overline{WF}_f \cdot WFDIST_{fa} \right) \cdot \overline{capsh}_{fa}$	$f \in K$	(16)
$WFDISTK_{fa} = \frac{\overline{WF}_f \cdot WFDIST_{fa}}{WFKAV_f}$	$a \in A$, $f \in K$	(17)
$WFREAL_f = \overline{WF}_f / CPI$	$f \in F$	(18)

Commodity market block

$QXAC_{ac} = \theta_{ac} \cdot QA_a$	$a \in A$, $c \in CX$	(19)
$QX_c = \sum_{a \in A} QXAC_{ac}$	$c \in CX$	(20)
$QX_c = \alpha_c^e \cdot \left(\sum_{r \in R} \delta_{cr}^e \cdot QE_{cr}^{\rho_c^e} + (1 - \sum_{r \in R} \delta_{cr}^e) \cdot QD_c^{\rho_c^e} \right)^{\frac{1}{\rho_c^e}}$	$c \in (CE \cap CD)$	(21)
$\frac{QE_{cr}}{QD_c} = \left(\frac{PE_{cr}}{PDS_c} \cdot \frac{1 - \sum_{r \in R} \delta_{cr}^e}{\delta_{cr}^e} \right)^{\frac{1}{\rho_c^e - 1}}$	$c \in (CE \cap CD)$, $r \in R$	(22)
$QX_c = QD_c$	$c \in (CD \cap CEN)$	(23)
$QE_{cr} = \alpha_{cr}^e \cdot \left(\frac{PW_{cr}}{pwe_{cr}} \right)^{\rho_{cr}^e}$	$c \in (CE \cap CD)$, $r \in R$	(24)
$QQ_c = \alpha_c^m \cdot \left(\sum_{r \in R} \delta_{rc}^m \cdot QM_{rc}^{-\rho_c^m} + (1 - \sum_{r \in R} \delta_{rc}^m) \cdot QD_c^{-\rho_c^m} \right)^{-\frac{1}{\rho_c^m}}$	$c \in (CM \cap CD)$, $r \in R$	(25)
$\frac{QM_{rc}}{QD_c} = \left(\frac{PDD_c}{PM_{rc}} \cdot \frac{\delta_c^m}{1 - \sum_{r \in R} \delta_{rc}^m} \right)^{\frac{1}{1 + \rho_c^m}}$	$c \in (CM \cap CD)$, $r \in R$	(26)
$QQ_c = QD_c$	$c \in (CD \cap CMN)$	(27)
$QT_c = \sum_{r \in R} \sum_{c' \in C'} \left(icm_{cc'} \cdot QM_{rc'} + ice_{cc'} \cdot QE_{c'r} + icd_{cc'} \cdot QD_{c'} \right)$	$c \in CT$	(28)

Income and expenditure block

$YF_f = \sum_{a \in A} \overline{WF}_f \cdot WFDIST_{fa} \cdot \overline{QF}_{fa}$	$f \in (K \cup LNMO)$	(29a)
$YF_f = \sum_{a \in A} \overline{WF}_f \cdot \overline{WFDIST}_{fa} \cdot QF_{fa}$	$f \in LMO$	(29b)
$YIF_{if} = shif_{if} \cdot [YF_f - (\sum_{r \in R} trnsfr_{rf} \cdot EXR)]$	$i \in INSD$, $f \in F$	(30)
$YI_i = \sum_{f \in F} YIF_{i,f} + \sum_{i' \in INSDNG'} TRII_{i\,i'} + \left(trnsfr_{i\,gov} \cdot CPI\right) + \left(\sum_{r \in R} trnsfr_{ir} \cdot EXR\right)$	$i \in INSDNG$	(31)
$TRII_{i\,i'} = shii_{i\,i'} \cdot (1 - MPS_{i'}) \cdot (1 - TINS_{i'}) \cdot YI_{i'}$	$i \in INSDNG$, $i' \in INSDNG'$	(32)
$EH_h = \left(1 - \sum_{i \in INSDNG} shii_{ih}\right) \cdot (1 - MPS_h) \cdot (1 - TINS_h) \cdot YI_h$	$h \in H$	(33)
$QH_{ch} = \gamma_{ch} + \frac{\beta_{ch} \cdot \left(EH_h - \sum_{c \in C} PQ_c \cdot \gamma_{ch}\right)}{PQ_c}$	$c \in C$, $h \in H$	(34)
$QINV_c = \overline{qinv}_c \cdot IADJ$	$c \in C$	(35)
$YG = \left(\sum_{i \in INSDNG} TINS_i \cdot YI_i\right) + \left(\sum_{a \in A} tva_a \cdot PVA_a \cdot QVA_a\right) + \left(\sum_{a \in A} ta_a \cdot PA_a \cdot QA_a\right)$ $+ \left(\sum_{r \in R} \sum_{c \in CM} tm_{rc} \cdot EXR \cdot pwm_{rc} \cdot QM_{rc}\right) + \left(\sum_{c \in CE} \sum_{r \in R} te_{cr} \cdot EXR \cdot pwe_{cr} \cdot QE_{cr}\right)$ $+ \left(\sum_{c \in C} tq_c \cdot PQ_c \cdot QQ_c\right) + \left(\sum_{r \in R} trnsfr_{govr} \cdot EXR\right)$		(36)
$TINS_i = \overline{tins}_i + TINSADJ$	$i \in INSDNG$	(37)
$EG = \sum_{c \in C} PQ_c \cdot \overline{QG}_c + \sum_{i \in INSDNG} trnsfr_{i,gov} \cdot CPI$		(38)

System constraint block for static solution and real investment

$QFS_f = \sum_{a \in A} \overline{QF}_{fa}$	$f \in (K \cup LNMO)$	(39a)
$QFS_f = \sum_{a \in A} QF_{fa}$	$f \in LMO$	(39b)
$QQ_c = \sum_{a \in A} QINT_{ca} + \sum_{h \in H} QH_{ch} + QG_c + QINV_c + qdst_c + QT_c$	$c \in C$	(40)
$\sum_{r \in R} \sum_{c \in CM} pwm_{rc} \cdot QM_{rc} + \sum_{r \in R} \sum_{f \in F} trnsfr_{rf} = \sum_{r \in R} \sum_{c \in CE} pwe_{cr} \cdot QE_{cr} + \sum_{i \in INSD} \sum_{r \in R} trnsfr_{ir} + \overline{FSAV}$		(41)
$\overline{FSAV} = \overline{KFLOW} + \overline{FDI}$		(42)
$YG = EG + \overline{GSAV}$		(43)
$\left[\sum_{i \in INSDNG} mps_i \cdot (1 - TINS_i) \cdot YI_i\right] + \overline{GSAV} + (EXR \cdot \overline{FSAV}) = \sum_{c \in C} PQ_c \cdot QINV_c + \sum_{c \in C} PQ_c \cdot qdst_c$		(44)
$PK = \sum_{c \in C} PQ_c \cdot \overline{qinvsh}_c$		(46)
$IREAL_f = \left(\sum_{c \in C} PQ_c \cdot QINV_c\right) \Big/ PK$	$f \in K$	(47)

Investment allocation, capital accumulation and equations changed as of second within-period solution (*t stands for all within-period solutions but the first*)

$INVSH_{fa,t} = \overline{capsh}_{fa} \cdot [1 + \kappa \cdot (WFDISTK_{fa,t-1} - 1)]$	$a \in A,\ f \in K$	(48)
$QVA_a = \alpha_a^{va} \cdot \left(\sum_{fa \in F} \delta_{fa}^{va} \cdot QF_{fa}^{-\rho_a^{va}} \right)^{-\frac{1}{\rho_a^{va}}}$	$a \in (AK \cup ALMO)$	(49)
$WF_f \cdot \overline{WFDIST}_{fa} = PVA_a \cdot (1 - tva_a) \cdot QVA_a \cdot \left(\sum_{f \in F} \delta_{fa}^{va} \cdot QF_{fa}^{-\rho_a^{va}} \right)^{-1} \cdot \delta_{fa}^{va} \cdot QF_{fa}^{-\rho_a^{va}-1}$	$a \in A,\ f \in K$	(50)
$YF_f = \sum_{a \in A} WF_f \cdot \overline{WFDIST}_{fa} \cdot QF_{fa}$	$f \in K$	(51)
$WFKAV_f = \sum_{a \in A} \left(WF_f \cdot \overline{WFDIST}_{fa} \right) \cdot \overline{capsh}_{fa}$	$f \in K$	(52)
$WFDISTK_{fa} = \frac{WF_f \cdot \overline{WFDIST}_{fa}}{WFKAV_f}$	$a \in A,\ f \in K$	(53)
$WFREAL_f = WF_f / CPI$	$f \in K$	(54)
$IREALAC_{fa,t} = INVSH_{fa,t} \cdot IREAL_{f,t-1}$	$a \in A,\ f \in K$	(55)
$KGR_{f,t} = \frac{IREAL_{f,t-1}}{QFS_{f,t-1}} - \overline{d}$	$f \in K$	(56)
$KGRAC_{fa,t} = \frac{IREALAC_{fa,t}}{QF_{fa,t-1}} - \overline{d}$	$a \in A,\ f \in K$	(57)
$QFS_{f,t} = QFS_{f,t-1} \cdot (1 + KGR_{f,t})$	$f \in K$	(58)
$QF_{fa,t} = QF_{fa,t-1} \cdot (1 + KGRA_{fa,t})$	$a \in A,\ f \in K$	(59)
$QFS_f = \sum_{a \in A} QF_{fa}$	$f \in K$	(60)
$\left(\overline{WF}_l \cdot \overline{WFDIST}_{la} \right)_t \cdot \left[1 + (CPI_t - CPI_{t-1}) \cdot inadj_{la} \right] =$ $\left[PVA_a \cdot (1 - tva_a) \cdot QVA_a \cdot \left(\sum_{l \in L} \delta_{la}^{va} \cdot QF_{la}^{-\rho_a^{va}} \right)^{-1} \cdot \delta_{la}^{va} \cdot QF_{la}^{-\rho_a^{va}-1} \right]_t$	$a \in (ALMO \cup APU)$, $l \in (LWAUSK \cup LSK)$	(61)
$QFS_{f,t} = QFS_{f,t-1} \cdot (1 + lfgr_{f,t})$	$f \in L$	(63)